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Influence of Ball Position on Playing Space in Spanish Elite Women's Football Match-Play

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ABSTRACT

The aims of this study were to examine the playing area in female football matches according to the position of the ball. We investigated: 1) the space between the two offside lines (the length), 2) the width, 3) the distance from the least advanced defender to the goal line in defensive activity, 4) the distance from the least advanced attacker to her goal line in attacking activity, 5) the distance between the goalkeeper and her nearest attacking team mate, and 6) the distance between the goalkeeper and her nearest defending team mate. With these measurements we were also able to obtain 7) the individual playing area used during female professional football matches. Data were collected during Spanish matches and notated post-event using the Amisco® system. A total of 2756 game situations were coded from four games. The distribution of players was significantly ($p<0.001$) wider and shallower when the ball was in the central areas of the field (37.07 m x 43.84 m "zone 3" and 36.36 m x 42.82 m "zone 4") than when the ball was in a "building up play" zone (43.31 m x 39.24 m "zone 1"), and the finishing and scoring zone (48.14 m x 39.80 m "zone 6"). The values obtained for the individual playing area varied between 77.91 m^2 and

Reviewers: Andrew Hulton (Liverpool John Moores University, UK)
Holden MacRae (Pepperdine University, USA)
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96m^2. The players stood further from the goals depending on the position of the ball. The spaces at the back of the defensive line changed from 45.75 m to 6.90 m (to the goal line) depending on the position of the ball. In addition, the spaces at the back of the less advanced attacking line changed from 16.45 m to 52.24 m, depending on the position of the ball. There were significant differences ($p<0.05$) in playing spaces between all zones. The results show that the spaces were significantly different depending on the ball position. Changes in playing space are presented as an important factor to consider when designing game-specific training activities for female football.

Key words: Association Football, Female Soccer, Game-Related Practice, Performance Analysis, Small-Sided Games Training

INTRODUCTION

Female football is growing as an internationally competitive team sport [1]. While there are obvious differences in playing intensity between the men's and women's games, the nature of football competition, in terms of work-rest ratios, and proportion of time spent in high- and very-high intensity running is similar between men and women [2-4]. The playing area is also presented as a tactical factor that might influence an athletes' decision-making in football. Therefore, this playing space should be considered when interpreting the real demands of the game [5]. In matches, the offside rule contributes to a reduction of the space among outfield players because teams tend to advance the position of the back four lines, placing 20 players in a reduced area of the pitch [6]. In female football, the distance between the two offside lines varied between 36.16 and 46.88 metres [7].

It is likely that reductions in playing space can impact an athlete's decision-making. Several studies have reported the effect of changing space and time on football match performance [8-12] with factors such as the playing styles, the ability to counter-attack, and distribution of opponents across the field all influencing the space and time available to attacking players. Thus, knowledge of how playing spaces change under different circumstances in a game can provide useful information to coaches who design training tasks to develop game awareness and tactical skills.

The playing space is influenced by the location of the ball on the pitch [13]. Different space areas may be expected depending on whether the ball is in one of the six zones of the 11 v 11 pitch. Bangsbo and Peitersen [14] stated that "build up play" (i.e., the construction of attack, beginning with the first attacking options) and preventing finishing phases occurred near to the player's own goal, establishing play and transitioning occurred in the midfield, whereas penetration and finishing took place near the opponent's goal. There are specific technical–tactical skills linked to each phase of play and each part of the pitch. An analysis of the available space in which players have to perform during match-play would appear to be useful for training purposes. From a specificity viewpoint, it would appear that technical-tactical skills training employing similar spatial-temporal constraints to those observed in matches may provide the greatest transfer of skills to the competitive environment [15]. This perspective views training in a game-specific context whereby the training requirements are matched to the competitive demands of match-play [16].

Knowledge of the space in which blocks of players move in relation to the goal line is also relevant in order to understand the space behind the defensive lines. Those teams that play

with more forward lines in order to capture the ball nearer to the opponent's goal reduce the space available to the opposing team. The study of these spaces may provide insight into the playing styles of different teams.

The existing distance from the goalkeeper to the least advanced player of the back-four line (fullbacks and centerbacks) is presented as another significant variable to consider when designing game-specific training tasks. Some authors have highlighted the importance of goalkeeper match analysis information in designing specific exercises for their training, in order to assure a workout with game-like situations [17, 18]. The present study attempts to show the actual distance between the goalkeeper and defenders in matches in order to provide coaches further spatial information when designing game-specific training tasks.

Our study seeks to develop information on the playing spaces, as well as the individual playing area for each player as a way of better understanding the spaces to be used in training tasks. At present, the exercises most used in training are small sided games (SSG), and there is a growing interest in them as a football-specific training activity. Reilly [16] highlighted the value of training with the ball, notably using activity drills in small groups. Moreover, it has been suggested that preparation for competition is optimized when technical, tactical and physiological requirements are integrated in the specific phases of preparation [16]. Therefore, SSGs seem to be a suitable tool to integrate fitness, technical and tactical training into a holistic process.

Originally, SSGs were mainly used for developing technical and tactical abilities [19]. However, in recent years, studies have been mainly focused on demonstrating the suitability of SSGs for physical conditioning [20, 21]. In addition, the impact of changes of different constraints (pitch size, player number, coach encouragement, etc.) on physiological responses [22, 23]; and technical requirements [24, 25] has been examined. This interest in physiological and technical aspects of SSGs is in direct contrast with a lack of studies focused on the tactical aspect of this training tool.

Small-sided games (also referred to as game-centred learning, teaching games for understanding, or game-based training) can use very few players (e.g., 1 v 1, 2 v 2) or the entire team (11 v 11). If the concept of specificity is important for skill acquisition (with which most coaches and sport scientists would agree), then developing game-specific situations that replicate the demands of football competition (in terms of playing space) is critical. In order to replicate these demands, we first need to understand these demands. This study provides a first step towards understanding the game spaces involved in elite women's football competition.

However, the studies that we have analyzed in relation to SSGs do not follow a criterion about the space to be used. For example, spaces as diverse as 416.6 m^2, [3] or 250 m^2 per individual [24] or 40 m^2 per individual [19] have been recommended. In our opinion, there is no clear idea of the ideal space to use. Through our study, by checking interpersonal spaces in competition, we can ascertain the spaces that should be used in the SSG (Table 1).

The aims of this study were to examine the playing area according to the position of the ball. We investigated: the space between the two offside lines, the length at which the 20 field players operate; we have also measured the width, and from these two measurements we calculated a theoretical measure of the individual playing area. This enabled us to better understand individual spaces and the approach to be used in training. We measured the distance from the least advanced defender to the goal line; in defensive activity, the distance from the least advanced attacker to her goal line; in attacking activity, the distance between the goalkeeper and her nearest attacking team mate and the distance between the goalkeeper and her nearest defending team mate during professional female football matches. We

sought to analyze how mobility and variability of play is influenced according to the position of the ball in the spaces in which all players operate. This information is important when considering the process of designing training tasks for football players.

METHOD

MATCH SAMPLE

Four Spanish league female football matches (1st female Spanish Division) were monitored using a multiple-camera match analysis system (Amisco Pro®, version 1.0.2, Nice, France). The movements of all 22 players were observed during the whole game duration by means of 8 stable, synchronized cameras positioned at the top of the stadium (sampling frequency 25 Hz). Signals and angles obtained by the encoders were sequentially converted into digital data and recorded on 6 computers for post-match analyses. Ethics approval for all experimental procedures was granted by the University of Granada Human Research Ethics Committee. The data owner has consented to its use for this study.

PROCEDURE

Data were collected from a total of 2756 activities. From the stored data, the area including all the outfield players, the distance from the goalkeepers to the least advanced defender and the distance of the block of players (the main group of players) to the goal lines were obtained by specially developed software (Athletic Mode Amisco Pro®, Nice, France) [26-28]. Data were recorded at intervals of 5 seconds in situations where the ball was in play. Records where the ball was out of play were removed. The analysis required the field to be divided into six zones (Figure 1). Each zone was 17.3 meters long. The length was the distance between the two horizontal defensive lines parallel to the goal lines and the width between the two vertical lines parallel to the touch lines. Width was defined as the distance between the widest players on the right and left of the pitch. The horizontal lines passed over the least advanced defender of each team. The perpendicular lines passed over the players nearest to the touchlines. The individual playing area was obtained by dividing the width by

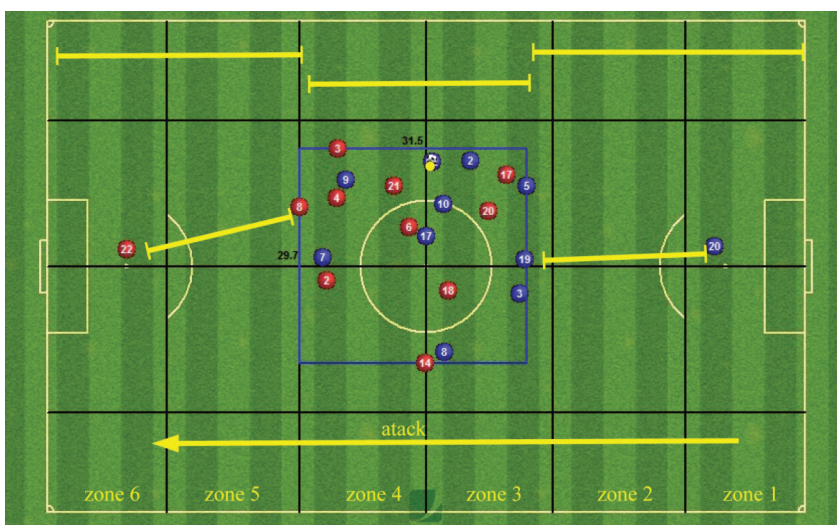

Figure 1. Schematic Representation of the Six Zones Used in the Analysis All Zones were Determined Using Athletic Mode AmiscoPro® (Nice, France)

the length among the twenty field players. Distances between the goalkeeper and the least advanced defender were collected from attacking and defending teams. Only open play situations (i.e., where the ball was in play) were included in the analysis. The distance from the block of players to the goal lines was established by measuring the distance from the horizontal defensive line to the goal line; the horizontal line passed over the goalkeeper's nearest team-mate (Figure 1).

STATISTICAL ANALYSIS

Data were tested for normality using a Kolmogorov-Smirnov test. When variables did not show a normal distribution, a Kruskal-Wallis one-way analysis of variance was applied. In cases where variables were normally distributed, a one-way ANOVA was applied. Six separate one-way ANOVAs were run on playing area, length, width, distance between both defending and attacking goalkeepers and their less advanced team-mates and the distance between the goal lines and less advanced attackers and less advanced defenders. When significant interaction effects were found, Games-Howell post-hoc comparisons were applied. All statistical analyses were carried out using IBM SPSS Statistics-v.19.0 for Windows, and statistical significance was set at $p<0.05$.

RESULTS

Results obtained in the analysis of the play areas are shown in Table 2. The distribution of the players was significantly ($p<0.001$) wider and shallower when the ball was in the central areas of the field (37.07 m x 43.84 m "zone 3" and 36.36 m x 42.82 m "zone 4") than when the ball was in a "building up play" zone (43.31 m x 39.24 m "zone 1"), and the finishing and scoring zone (48.14 m x 39.80 m "zone 6").

The data suggest that the space length was shorter in zone 4, and longer in zone 6. It also shows that the width progressively increased between zones 1 to 4, and decreased again in zones 4, 5 and 6. When the ball was in areas close to the defensive goal, the width of the block of players tended to decrease.

In summary, these results demonstrate that the behavior of the teams varies according to the playing spaces available, and the position of the ball.

Table 2 shows that the individual playing area varied between 77.91 m^2 and 96.19 m^2 depending on the position of the ball. Even taking into account the standard deviation, individual spaces were not greater than 110 m^2. There were significant differences between the individual playing area when the ball was in the midfield positions and when it was near the goal. It is important to clarify that the value related to the individual playing area was obtained by dividing the length by the width among the 20 players; therefore, it is necessary to analyze the data of the individual playing area observing the length and width in each zone.

In summary, the square footage in which women footballers move in individual space is less than most "individual playing areas" shown in studies examining the behavior of male and female players in SSG.

Table 2 shows the distance of the block of players to the goal lines. The players stood further from the goals depending on the position of the ball. The spaces at the back of the defensive line changed from 45.75 m to 6.90 m (to the goal line) depending on the position of the ball. In addition, the spaces at the back of the less advanced attacking line changed from 16.45 m to 52.24 m, depending on the position of the ball. There were significant differences ($p<0.05$) in playing spaces between all zones.

In summary, these results demonstrate the team movements relative to the position of the ball, and provide the actual playing spaces available in competition.

Table 1. Playing Space in Spanish Elite Women's Football Match-Play with Respect to the Position of the Ball

Position of the ball					1.Length (m)		2.Width (m)		3. Distance from defender to goal-line (m)		4. Distance from attacker to goal-line (m)		5. Distance between goalkeeper and defender (m)		6. Distance between goalkeeper and attacker (m)		7.Individual playing area (m^2)	
			n	%	av	sd	av	sd	av	sd	av	sd	av	sd	av	sd	av	sd
Zone 1			285	10.34	43.31	7.55	39.24	8.13	45.75	7.56	16.45	11.08	26.58	4.44	12.39	7.44	84.99	23.42
Zone 2			393	14.26	39.43	5.52	42.68	8.47	43.75	6.93	22.00	7.40	26.44	4.51	16.09	5.33	84.37	21.67
Zone 3			662	24.02	37.07	5.33	43.84	18.37	36.90	13.38	31.45	7.35	24.27	9.93	20.83	4.80	81.63	39.21
Zone 4			579	21.01	36.36	4.21	42.82	17.61	27.95	7.53	40.82	7.52	20.76	9.33	25.25	4.53	77.91	32.72
Zone 5			456	16.55	40.21	4.21	40.49	7.01	16.93	6.72	48.63	6.59	14.51	4.91	28.25	4.88	81.25	16.06
Zone 6			381	13.82	48.14	3.96	39.80	7.73	6.90	7.51	52.24	8.02	7.21	4.67	28.68	5.74	96.19	22.63
Total			2756	100.0	39.95	6.40	41.87	13.50	29.46	15.80	36.24	14.19	20.11	9.82	22.52	7.58	83.54	29.34
											level of significance							
zone 1	vs.	zone 2			p<0.001		p<0.001		p<0.05		p<0.001		ns		p<0.001		ns	
zone 1	vs.	zone 3			p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		ns	
zone 1	vs.	zone 4			p<0.001		p<0.05		p<0.001		p<0.001		p<0.001		p<0.001		p<0.05	
zone 1	vs.	zone 5			p<0.001		ns		p<0.001		p<0.001		p<0.001		p<0.001		ns	
zone 1	vs	zone 6			p<0.001		ns		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001	
zone 2	vs.	zone 3			p<0.001		ns		p<0.001		p<0.001		p<0.001		p<0.001		ns	
zone 2	vs.	zone 4			p<0.001		ns		p<0.001		p<0.001		p<0.001		p<0.001		p<0.05	
zone 2	vs.	zone 5			Ns		p<0.05		p<0.001		p<0.001		p<0.001		p<0.001		ns	
zone 2	vs.	zone 6			p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001	
zone 3	vs.	zone 4			Ns		ns		p<0.001		p<0.001		p<0.001		p<0.001		ns	
zone 3	vs.	zone 5			p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		ns	
zone 3	vs.	zone 6			p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001	
zone 4	vs.	zone 5			p<0.001		ns		p<0.001		p<0.001		p<0.001		p<0.001		ns	
zone 4	vs.	zone 6			p<0.001		p<0.05		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001	
zone 5	vs.	zone 6			p<0.001		ns		p<0.001		p<0.001		p<0.001		ns		p<0.001	

The distance from the goalkeeper to the attacking opponent and from the goalkeeper to the nearest team mate in defense was dependent on the ball position. The results showed significant differences ($p<0.001$) in all spaces except when the ball was in zone 1 vs. zone 2 in defense, and when the ball was in zone 5 vs. zone 6 in attack. The distance from the goalkeeper to the defensive line was as great as 26.58 m and as short as 7.21 m, depending on the position of the ball. The distance to the attacking goalkeeper ranged between 12.39 m to 28.68 m.

In summary, these results demonstrate that the goalkeeper modifies her position according to the location of the ball.

DISCUSSION

The relationship between space and time during football matches reflects the constant adaptation to constraints due to the confrontation between two opposing teams [5]. Several studies have investigated the effect of space and time on football match performance [9-12]. These studies have shown that playing distances may vary according to the location of the ball on the pitch. The spatial-temporal demands differ according to pitch location due to the different configurations of play which emerge between two opposing teams [5].

Our data demonstrate that when the ball was in the midfield area, the length was reduced to 36.36 m. Knowledge of this space provides insight for coaches in preparing specific training tasks aimed at establishing play in the midfield area. Equally, the results demonstrated changes in the area of play when the ball's position was either near one's own goal or if the opponent was near to her goal (length range between 36.36 m and 48.14 m). These playing spaces are useful in designing tasks in areas where the purpose of the training activity is to "build up play", establish play, or to develop penetration (i.e., the team attacked with the intention of progressing to the goal) or finishing (i.e., goal scoring) skills [14].

While previous research groups have investigated game spaces in football [7], this study provides new data on the width of the game that have not been previously documented. The analysis of the width of the game also demonstrated significant differences depending on the position of the ball. As the position of the ball became closer to the goals, the width in which the players competed was reduced. These distances allow coaches to better understand the wide spaces that are used to train specific behaviors; e.g., in the initial attacking phases or during shots on goal.

It is interesting to note that playing spaces in the center of the field were wider than they were deep, while in areas near the goals they were longer than they were wide. These findings suggest that training tasks designed to "build play" and keep possession should be performed in wide, shallow spaces. However, game-specific training activities near the goals should use spaces that are deeper rather than wide. These findings are likely to be particularly useful for those coaches using small-sided games to promote game awareness, and technical skills [3]. An understanding of how playing spaces change when in center-field or near the goals will likely provide coaches with specific information on the best method of utilizing space to develop game skills.

The results for "individual playing area" show an approach to playing spaces in the competition of women footballers in Spain. To design tasks for reduced training situations for women footballers the individual playing area should not exceed 110 m^2. In studies, we see that there is a broad range and excessively large spaces are used that are very far from game-specific situations, particularly for women who have used individual spaces of 416.6 m^2 [3] (see Table 1). It is necessary to evaluate other styles of play in other countries, but this study allows us to know more about the individual spaces that are developed in competition.

We are aware that the relative value of the individual playing area is calculated mathematically, and that a deeper analysis is required about the "pull" generated by the ball in that space, likely reducing space for interaction. However, we also believe that we have generated questions for future studies on SSGs and highlighted the importance of considering playing spaces when developing training activities for female football players.

The present results demonstrate that playing spaces vary according to where teams are located in relation to the goal line. The data also show that spaces vary according to the position of the ball. When a team began the attack in zone 1, the defensive line was located at 45.75 m from their own goal line; however, when the attacking team was in zone 6, the distance was reduced to 6.9 m. These findings may reflect the aim of coaches to improve the movement of players to the back of the opponents' defense.

It is important to establish that the distance of the attacking team to its goal line varied significantly from 52.24 m to 16.45 m depending on the position of the ball, thus providing information of spaces that were left at the back when the team lost possession of the ball. These spaces can be transferred to training situations to improve attacking and defensive transitions. An understanding of the distances created in attacking and defending zones could assist with the development of training drills, but also may provide specific information on the oppositions' style of play.

The third stage of this study examined the distance between goalkeepers and the back four line. This is the first study to analyze this aspect of the game in female football, despite the importance of game-specific training for this position [17]. The results showed that the distance from the goalkeeper to the least advanced defender of her team increased significantly as the ball moved further away from her goal. Both attacking and defending teams showed this same tendency. Our results might be partially explained by two common goalkeeper's tactical behaviours such as protecting the goal and intercepting passes behind the back four line. Firstly, goalkeepers need to be near enough to their goals to be able to save shots made from any part of the pitch [17]. De Baranda et al. [17] showed that goalkeepers performed more frequently in the penalty area (44.4%) and goal area (17.7%) than outside the penalty area (6.6%). Thus, although the block of outfield players advanced to the position of the ball, goalkeepers advanced to a lesser extent due to their inability to separate from the goal. However, goalkeepers did not stay permanently near their goals.

The greater average distance between the goalkeeper and the least advanced defender was not longer than 26.51 ± 7.21 m when the ball was in zone 6. Goalkeepers in those situations most likely minimized the distance between themselves and the back four line because this space could have been used by the opposing forwards to receive the ball and directly challenge them. This intermediate position between the goal and the least advanced defender might have allowed goalkeepers to both intercept passes behind the back four and save long distance shots. These findings have important practical implications. For example, our results highlight the importance of creating situations where the goalkeeper has to intervene outside the penalty area, especially if her team plays with an advanced defence. Results from the present study might represent a further step for the design of those situations by providing the actual distance between the defence and goalkeeper.

It has previously been suggested that training should include tasks that involve decision-making processes and tactical responses from players, in order to reach specificity with real match-play [29]. Future research could use findings from the present study to design suitable distances between goalkeepers and defenders in training tasks. Although these findings have clear practical implications for women's football coaches, there are some limitations of our study that warrant discussion. One limitation was that all the data was collected from Spanish

League matches. Differences in the playing space may exist between different leagues and consequently the applications of this study may be most relevant to players within the Spanish League. Further studies on football players from other elite competitions, genders, and age groups are warranted. In addition, although these findings have implications for the development of small-sided training games and drills, currently, the Amisco technology is only used in competitive matches. Further studies comparing competition spaces with those used in small-sided training games are warranted.

CONCLUSION

This study demonstrates that the real playing spaces in competition games change depending on the position of the ball. The distances of playing length increased, while those of the playing width decreased as the ball approached the two goals (zones 1, 2, 5 and 6) from the midfield area (zones 3 and 4). The individual playing area is reduced to between 77.91 m^2 and 96.19 m^2 and, surprisingly, is less than the individual playing areas used in the majority of studies on SSG in women's soccer. This study also demonstrated the different distances between the goalkeeper and her nearest team-mate in attacking and finishing spaces. This distance was as short as 7.21 m when being pressured by the opponent, while the distance between the goalkeeper and the rear-most defender was as long as 20.76 m to 24.27 m when the attacking team played the ball in midfield (zones 3 and 4). By using this information, coaches can design suitable pitch sizes in small sided games and other training drills to ensure technical and tactical specificity of the training stimulus. We also believe that this study contributes to a greater understanding of the playing spaces that should be used in future research on SSGs.

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